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Lubricating Device

The invention relates to a lubricating device for gear trains, especially for wind power stations, with at least two gear stages which are located next to one another and which are dynamically connected to one another, and a lubricant circuit to which at least one filter unit is connected.

Lubrication devices for gear trains in wind power stations are known and readily available on the market, in which in the manner of closed circulating lubrication the lubricant, especially in the form of lubricating oil, is removed by means of gear oil pumps from the gear sump of the gear housing with the gear stages, supplied to filtering by means of the filter unit, and then, filtered in this way, is discharged again to the interior of the gear housing in order to thus remove fouling, including in the form of metal shavings, from the lubricant. In spite of these measures, premature damage to the gears which often occurs after six months takes place in practical applications, both within the planet stage and also on the spur wheel stage, which generally form the two gear stages

for the rotor of a wind power station. In particular, the planet stage often fails due to defective planet bearings, as do the gear oil pumps of wind power stations due to metal shavings which occur with increased frequency in the lubricant circuit, the reason for this being that within the spur wheel stage due to the formation of resting zones with large areas for the lubricant (oil) it becomes possible for heavy metal particles to settle there. Often lubricant or oil exchange takes place only in the area of the spur wheel stage so that lubricant exchange takes place only conditionally and contaminated or dirty lubricant can remain on the sides of the planet stage and can cause damage there.

On the basis of this prior art, the object of the invention is to further improve the known lubrication devices while retaining their advantages, such that they are reliable and economical in use and that they ensure long-lasting gear train operation; this contributes to increasing the time between expensive maintenance intervals. This object is achieved by a lubrication device with the features of claim 1 in its entirety.

In that, as specified in the characterizing part of claim 1, on one gear stage the lubricant which is circulating in the lubricant circuit is drawn off, cleaned by the filter unit and then can be delivered to the respective other gear stage, stationary resting zones for the lubricant within the gear housing with the gear stages are avoided and it is ensured that in definable time intervals all the lubricant circulating in the gear stages is delivered to the filter unit to be cleaned and filtered by it. For an average person skilled in the art in the area of lubrication devices, especially in the area of wind power stations, it comes as a surprise that with the measure of permanent circulation while avoiding stationary resting zones in the lubricant or gear oil bath he obtains an improved possibility for cleaning the lubricant flow by way of the filter unit. In particular, the heavy metal particles which otherwise settle can be continuously supplied to the circulation process; this leads to relief of the gear oil pumps and ultimately also of the gear stages, from which serious contaminants are

removed and which can perform their gear function for a long time, to which the improved lubricant delivery at the respective gear stage also contributes.

In one preferred embodiment of the lubrication device as claimed in the invention, provision is made such that in order to implement splash lubrication, the gear stages each individually and at least partially pass through a type of immersion bath with a lubricant reserve which has a subdivision such that each gear stage is assigned its own bath area. Preferably the subdivision and the lubricant amount in the immersion bath are chosen such that overflowing lubricant from one gear stage with lubricant supply travels to the bath area with the following gear stage and lubricant removal. This configuration provides on the one hand for optimum lubrication of the gear stages within the immersion bath of the lubricant and it is still ensured that within the immersion bath lubricant displacement and the respective continuous drawing off take place with the result that removal of fouling from the lubricant or gear oil bath is achieved continuously.

In another, especially preferred embodiment of the lubrication device as claimed in the invention, lubricant removal consists of a suction device and the lubricant supply consists of an injection device, in the gear housing for the respective gear stage the indicated devices mounted diagonally opposite one another extending through the upper and lower area of the housing. Due to this diagonal configuration, optimum lubricant distribution within the gear stages takes place and the transit time for the lubricant between the gear stages from the injection side to the suction side is likewise optimized.

Preferably the gear stage comprises a planet gear and a spur gear and by means of the planet gear it is possible to bring the rotor of the wind power station with its low rpm to higher rpm as required, in order to drive a generator for generating current or the like by means of the spur gear, in an obvious manner. For long-lasting and good lubricant operation it has proven favorable to provide

injection of a cleaned lubricant for the planet gear and to implement suction for contaminated lubricant on the spur gear stage.

The filter unit which is used preferably in the lubrication device in the direction of lubricant delivery first of all has a fine filter which is safeguarded with a bypass, followed by a coarse filter connected downstream in series. Cleaning results have been especially good when the filter fineness of the coarse filter is chosen to be approximately 5 to 10 times coarser than the filter fineness of the fine filter. Such a preferably suitable filter unit is described in DE 101 05 612 A1 of the applicant.

The lubrication device as claimed in the invention need not be limited to gear stages in wind power stations, but can also be used for other gear stages and gear configurations with and without planet gears.

The lubrication device as claimed in the invention will be detailed below using one embodiment as shown in the drawings. The single figure shows the lubrication device as claimed in the invention in the manner of a block diagram schematically and not to scale.

The lubrication device is used for a gear train which is designated as a whole as 10. The pertinent gear trains 10 which are shown in the figure are used in so-called wind power stations, in which a rotor (not shown), which can be driven by the force of the wind, delivers its output power to an input shaft 12 and after passing through the gear train 10 the respective output power is delivered to an output shaft 14 to which for example a generator (not shown) can be connected for generating electrical current. Since the rotor in general has very low rpm and the generator for its operation requires correspondingly higher input rpm, the gear train calls for a step-up ratio from low to high rpm by a factor i of for example 1 : 80. The pertinent gear train assemblies for wind power stations are conventional so that this no longer needs be detailed here.

Furthermore the pertinent gear trains generally have two gear stages 16, 18, and the respective gear stage in turn can consist of several stage parts. In particular, for the first gear stage 16 a so-called planet gear is used and for the second gear stage 18 a spur gear is used, the pertinent stages also being referred to as the planet stage or the spur stage. Furthermore, the lubrication device as claimed in the invention in the manner of a closed circle has a lubricant circuit 20. To propel the lubricant, a conventional motor pump unit 22 is used which is subsequently safeguarded in the lubricant delivery direction by way of a check valve 24 of conventional design. A filter unit 26 is connected subsequently between the motor pump unit 22 and the two gear stages 16, 18.

As furthermore is to be seen in the block diagram, on the second gear stage 18 the lubricant which is circulating in the lubricant circuit 20 is removed and then is supplied by way of the motor pump unit 22 to the filter unit 26 before the lubricant which has been cleaned in this way is then supplied to the respective other first gear stage 16. The pertinent lubricant circulation can be carried out independently of whether the rotor and accordingly the gear train 10 are in operation or not. In this manner, by way of a control which is not detailed, the lubricant can be cleaned even if the system itself is shut down, for example because, with respect to the prevailing wind, operation of the system would not be profitable.

To implement splash lubrication for gear stages 16, 18 a type of immersion bath 28 is provided which has a definable lubricant reserve and into which the gear stages 16, 18 with their gear wheels are at least partially immersed. A subdivision 30 is placed in the immersion bath 28, with each gear stage 16, 18 thus being assigned its own bath area 32, 34 in the process. In particular, the indicated subdivision and the lubricant amount in the immersion bath 28 are chosen such that the overflowing lubricant 36 (see arrow representation) travels from one gear stage 16 with lubricant supply 38 to the second bath area 34 with the following gear stage 18 with lubricant removal 40.

In the selected embodiment the lubricant removal 40 is formed from a suction device and the lubricant supply 38 is formed from an injection device, the pertinent suction and injection action being adjustable by way of the working capacity of the motor pump unit 22. In particular, the indicated injection device is configured such that, for the purposes of a spraying-on process, parts of the first gear stage 16 are covered or fogged with the lubricant over a large area.

As is furthermore to be seen in the figure, in the gear housing 10 for the respective gear stage 16, 18 the indicated devices 38, 40 are mounted diagonally opposite one another, the lubricant supply 38 extending through the upper part of the housing 10 and the lubricant removal 40 in the form of a suction device penetrating the housing area formed from the housing bottom. With respect to the diagonal configuration, it basically is also possible in one embodiment which is not detailed to supply the injection amount to the top of the spur wheel stage and to implement suction on the bottom of the planet stage. But since the planet stage in terms of its support is highly susceptible to fouling, it has proven advantageous to implement the previous diagonal routing. As already described, diagonal fluid guidance is promoted and improved in that the overflowing lubricant 36 is relayed from one bath area 32 into the other bath area 34 and then is available to a filtration process by way of the filter unit 26. Sedimentation or settling, especially of heavy fouling components such as metal shavings or the like, in the bath area 32 is thus effectively controlled.

The filter unit 26 can be provided with a filter element; but it has proven advantageous to first of all provide a fine filter 44 which is safeguarded with a bypass 42 (spring-loaded check valve) in the lubricant delivery direction, followed by a coarse filter 46 which is connected downstream in series. In normal operation provision is therefore made such that the fine filter 44 performs removal of fouling in the lubricant circuit 20, and should the pertinent fine filter fail 44 fail, especially should it be clogged with dirt, it would be possible for the bypass valve 42 to open and for it to then supply the fluid flow to the coarse filter 46, coarser dirt then being retained by way of the coarse filter 46 and in no case can it penetrate into the gear train 10 with its gear stages 16, 18 to cause damage. It

has been found to be especially favorable for this application if the coarse filter is designed to be 10 times more coarse than the filter stage of the fine filter 44. Thus the fine filter 44 can have a filter fineness of 5 μm and the coarser protective filter can have a filter fineness of 50 μm particle size. The pertinent, series-connected filter stages are prior art and it has proven especially effective to use filter units 26 according to the teaching of DE 101 05 612 A1 of the applicant for this area of application.

By a combination of suction from the oil sump on the spur wheel area and injection of lubricant into the planet stage after cleaning by way of the filter unit 26, lubricant supply for the gear train parts of wind power stations is achieved which ensures reliable and long-lasting, trouble-free operation even under harsh ambient conditions and with hard use.

The lubricant device as claimed in the invention can be used by itself as a modular unit; but it can also be installed as an additional system to standard circulation lubrication or to immersion bath lubrication. Furthermore, the possibility also exists of integrating an additional intake filter or intake screen (not shown) in the intake line to the motor pump unit 22 in order in this way to protect the hydraulic pump against damage caused by dirt. Furthermore, analysis of the contents of an intake screen yields conclusions regarding wear processes in the gear train. The subdivision of the bath areas within the gear housing can also be formed by ribs or stiffeners of the gear housing. The planet stage 16 shown in the figure has so-called planet wheels which revolve around the sun wheel shown lowermost in the figure, and viewed in the direction of looking at the figure the internal geared wheel is shown uppermost; the pertinent structure of the planet gearing is conventional so that it will not be further detailed here.

As shown in the figure, a gear stage or planet stage 16 forms the planet gearing or the so-called planet part of the gear train, conversely two gear stage or spur wheel stages 18 form the actual spur gear which is also called the spur part of the gear train. The diagonal lubrication concept

as claimed in the invention for the lubrication device can also be used for gear trains with a different number of gear stages. The check valve 24 inserted downstream in front of the pump 22 is optional and not absolutely necessary. In particular the pertinent check valve 24 would be suited for pressure limitation, and the oil flow from the check valve could then be routed to the intake side of the pump (not shown).